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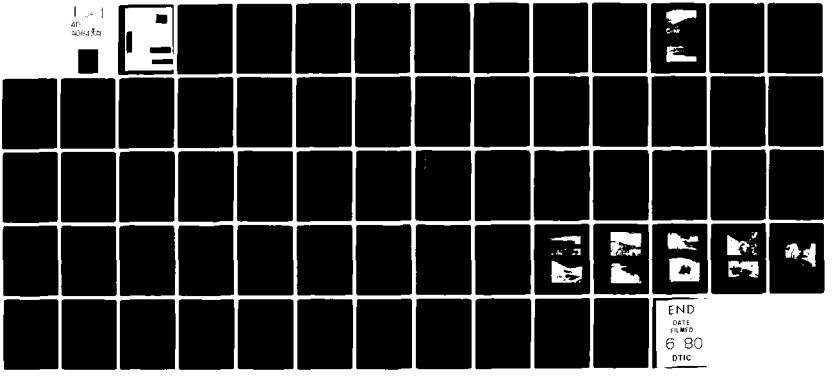

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/dydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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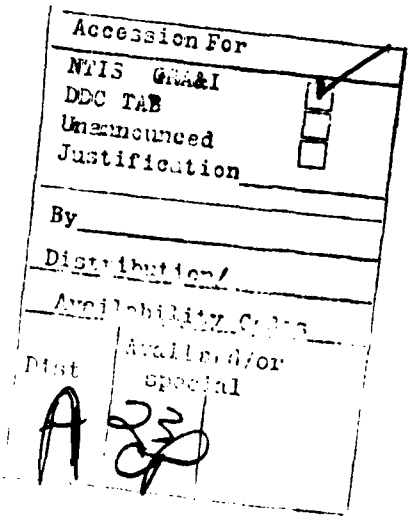

Name of Dam: Bear Creek Reservoir Dam
State: Virginia
County: Wise
USGS Quad Sheet: Wise
Coordinates: Lat 36° 58.1' Long 82° 32.0'
Stream: Bear Creek
Date of Inspection: December 11, 1979

BRIEF ASSESSMENT OF DAM

Bear Creek Dam is a zoned earthfill structure about 550 ft long and 45 ft high. The principal spillway consists of a rectangular concrete riser and a 48 inch diameter concrete outlet pipe which extends through the structure. There is an emergency spillway located at the right abutment. The emergency spillway consists of a 30 ft wide grass-lined earth channel with 1.5:1 side slopes. The dam is located on the right fork of Bear Creek about 2 miles east of Wise, Virginia. The reservoir serves as a water supply for the Town of Wise and is owned and maintained by the Town of Wise, Virginia.

Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the appropriate spillway design flood (SDF) is the ½ PMF. The spillway will pass 40 percent of the Probable Maximum Flood (PMF) or 80% of the SDF; however, tailwater conditions permit less than 30 percent of the PMF to be passed. During the SDF, the dam will be overtopped to a depth of 0.9 ft maximum, at a maximum velocity of 4.4 fps, and will be overtopped for a period of 1.0 hour. A haul road across the downstream channel, located approximately 200 ft downstream of the outlet pipe, creates

a restriction in the channel up to an elevation approximating the dam crest. During the SDF the downstream restriction will create a tailwater elevation of 2.1 ft maximum above the dam crest for a period of 4.5 hours. Overtopping of the haul road creates the potential for a failure and the resulting sudden drawdown in tailwater conditions likewise creates the potential for failure of the dam.

An evaluation of the stability condition could not be made since sufficient design data, calculations, and construction data were not available. The structure was, however, designed in accordance with U. S. Bureau of Reclamation standards. Based on review of available test boring data, the structure is founded on soils and on rock suitable for support of the dam.

The visual inspection revealed no serious problems. The embankment structure appears to have been constructed as shown on the "design" drawings.

The spillway is rated inadequate but not seriously inadequate and the dam is classified as "unsafe, non-emergency". It is therefore recommended that within two months of the date of notification of the Governor of the Commonwealth of Virginia, the owner engage the services of a professional engineering consultant to perform a detailed analysis of the effects created by the downstream haul road on the dam. Within six months of the notification of the Governor, the consultant's analyses and recommendations should be completed and the owner should have an agreement with the Commonwealth of Virginia for a reasonable time period in which all remedial measures will be complete. In the interim, an emergency operation

and warning plan should be developed.

The following routine maintenance and observation functions should be initiated as part of an annual maintenance program:

Vegetation should be routinely controlled. The slopes and crest of the structure and the emergency spillway should be mowed twice per year and all existing small trees or sapplings cut to the ground. Seepage present along the downstream toe should be monitored quarterly to detect any increase in flow rates which may cause piping within the embankment. The eroded area in the emergency spillway and rutted areas on the dam crest should be corrected. A staff gage should be installed to monitor water levels.

Prepared by:

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Jack G. Starr, P.E., R.A.
Chief, Engineering Division

Date: MAR 18 1980

Water Filtration Plant and Intake Structure

Overall View of Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BEAR CREEK RESERVOIR DAM
VA. NO. 19511

SECTION 1 - PROJECT INFORMATION

1.1 General:

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (See Reference 1, Appendix IV). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances: Bear Creek Reservoir Dam is a zoned earthfill structure approximately 550 ft long and 45 ft high.* The top of the dam is 15 ft wide and is at elevation 2540 msl. Side slopes are approximately 3 horizontal to 1 vertical (3:1) on the downstream side and 3 horizontal to 1 vertical (3:1) on the upstream side.

*Height is measured from the top of the dam to the downstream toe.

The principal spillway consists of a 4 feet 6 inch x 9 feet 6 inch reinforced concrete riser and a 48 inch concrete outlet pipe running through the dam. The riser crest is at elevation 2535 msl with an overflow weir at elevation 2533 msl. The riser has seven 12 inch square sluice gate inlets from elevation 2528 to 2504 msl used as water supply intakes, and a 24 inch square sluice gate at elevation 2499 msl used to drain the lake. A 10 inch diameter steel water supply pipe connects the riser with the water filtration plant at an invert elevation of 2499 msl. The 48 inch diameter outlet pipe runs approximately 296 ft under the embankment with an invert elevation at the riser of 2499 msl and an invert elevation at the outlet structure of 2496 msl. (See Plate No. 7, Appendix I)

There is an emergency spillway at the right abutment which is a vegetated earth channel with a bottom width of 30 ft and 1.5:1 side slopes. The crest elevation is 2533 msl. The bottom and right side of the emergency spillway is in cut and the left side is in fill. The spillway has a loose section of riprap across the bottom, centered on the control section. (See Plate No. 3, Appendix I)

1.2.2 Location: Bear Creek Dam is located on Bear Creek, 2 miles east of Wise, Virginia (see Plates 1 and 2, Appendix I). The impoundment is popularly known as the Wise Reservoir Dam.

1.2.3 Size Classification: The dam is classified as an "intermediate" size structure because of the dam height.

1.2.4 Hazard Classification: The dam is located in a suburban, forested area; however, based upon the downstream proximity of several homes located one-half to one mile downstream, the dam is assigned a

"significant" hazard classification. The hazard classification used to categorize a dam is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The Town of Wise, Virginia owns and operates the dam.

1.2.6 Purpose: Recreation and Town of Wise water supply.

1.2.7 Design and Construction History: The dam was designed and constructed under the supervision of Thompson and Litton, Inc. for the Town of Wise, Virginia. The structure was constructed by Appalachian Construction Company of Wise, Virginia and completed in 1964.

1.2.8 Normal Operational Procedures: The principal spillway is ungated; therefore, water rising above the crest of the riser inlet automatically is discharged downstream. Similarly, water is automatically passed through the emergency spillway in the event of an extreme flood which creats a pool elevation above that of the emergency spillway crest. Normal pool is maintained at elevation 2532 msl or one foot below the intake structure overflow weir. Normal flow through the reservoir is taken in through the water filtration plant intake and zero discharge is maintained downstream under normal conditions.

1.3 Pertinent Data:

1.3.1 Drainage Areas: The drainage area is 1.44 square miles.

1.3.2 Discharge at Dam Site: Maximum known flood at the dam site occurred in April 1977 and an estimated pool elevation of 2535± was observed.

Principal Spillway Discharges:

Pool Elevation at Crest of Dam (elev 2540) 133 CFS

Emergency Spillway Discharges:

Pool at Crest of Dam (elev 2540) 1892 CFS

1.3.3 Dam and Reservoir Data: See Table 1.1, below:

Table 1.1 DAM AND RESERVOIR DATA

Item	Reservoir				
	Elevation feet msl	Area Acres	Storage		Length Miles
			Acre Feet	Watershed Inches	
Crest of Dam	2540	40.5	808	10.54	.9
Emergency Spillway Crest	2533	36.0	576	7.51	.85
Principal Spillway Crest	2533	36.0	576	7.51	.85
Streambed at Downstream Toe of Dam	2494	-	-	-	-

SECTION 2 - ENGINEERING DATA

2.1 Design: The dam was designed and constructed under the direction of Thompson and Litton, Inc. (Wise, Virginia) for the Town of Wise, Virginia. Design data and construction specifications are available at Thompson and Litton's office. The hydrologic and hydraulic design report was not available and a stability analysis was not performed.

The dam site is located within the southeast portion of the Appalachian Plateau (locally Cumberland Plateau) Physiographic Province of Virginia. The Cumberland Plateau is a stream dissected plateau which is underlain by sedimentary rocks up to upper Pennsylvanian in age (see Reference 3, Appendix IV). The structure is underlain by rocks of the Norton Formation, which consist of alternate beds of sandstone and shale, interbedded with coal. The sandstones are commonly soft and micaceous while the shales are largely clayey. The Norton Formation is overlain by the Gladeville Sandstone, which is exposed in the spillway and abutment areas. The formation is basically a hard quartzose sandstone. Bedrock exposed at the site is essentially flat lying and no faults have been mapped in the immediate area. Five test borings were drilled at the site and this data is presented on Plate 8, Appendix I.

The dam is a zoned compacted earthfill embankment, consisting (as designed) of an impervious core and pervious shell. Design drawings are presented as Plates 3 through 7 of Appendix I. A core trench approximately 20 ft wide was to be excavated beneath the structure as shown on Plates 4 and 8 of Appendix I. The embankment was to be constructed

with select clay, silt, and sand derived from nearby borrow pits, to form an "impervious" core. The outer permeable shell was to be constructed with cobbles, sand, and rock fill from the cutoff trench and/or filter plant site. The upstream slope was to include a 12" riprap blanket extending from the upstream toe to approximately 1 ft± above the design maximum pool level. Embankment slopes of 3 horizontal to 1 vertical were planned on the upstream and downstream sides. The location of the principal spillway is provided on Plates 3 and 6. of Appendix I. Thirteen anti-seep collars at a 20 ft± spacing were specified in design for the 42 inch (I.D.) concrete pipe. A toe drain was not included in the design drawings. The bottom and right side of the emergency spillway is in cut material consisting of slightly to moderately weathered sandstone bedrock.

2.2 Construction: Construction records were kept during the project, but could not be located for this study. The dam was constructed by Appalachian Construction Company of Wise, Virginia and completed in 1964. Full time construction inspection was performed by Thompson and Litton, Inc. According to Thompson and Litton, local pressure grouting was performed in select areas of the cutoff trench prior to construction of the embankment. Comparison of design drawings with field inspection data indicates that a 48 inch diameter concrete pipe was substituted for the 42 inch square outlet conduit called for on the design drawings as the principal spillway outlet conduit. Comparison of design drawings with field inspection data indicates the dam was constructed essentially as planned.

2.3 Operation: There is no known operation and instrumentation procedure. The dam is inspected daily and maintained as a requirement of the water treatment plant operator's responsibility.

2.4 Evaluation: Engineering calculations are not available and there are no records available for dam performance. Design drawings provided by Thompson and Litton appear to be generally representative of the "as built" structure.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: At the time of inspection, the dam was in satisfactory condition. Field observations are outlined in Appendix III.

3.1.1 General: An inspection was made 11 December 1979 and the weather was clear with a temperature of 55°F. The pool and tailwater levels at the time of inspection were 2532 and 2494 msl, respectively, which correspond to normal levels. Ground conditions were dry at the time of the inspection. No previous inspection reports were available.

3.1.2 Dam and Spillway: There was tall grass (2 to 3 ft) present on the downstream and upstream embankment slopes and on portions of emergency spillway. Small trees (1 to 3" diameter) were growing at scattered locations along the center and right sides of the downstream slope and at a single location on the upstream slope. A rather well defined water saturated zone was encountered along the basal 1/3 to 1/4 of the downstream slope. This continuous zone included scattered wet spots, ponded water and iron-stained seepage. The combined flow of seepage along the right downstream toe toward the principal spillway outlet was estimated at 5 gpm. Two shallow erosion gullies up to 1 ft deep were observed along the right downstream slope-abutment interface and another shallow gully of similar size was present along the left downstream slope-abutment interface. This gully; however, appeared to be corrected with a sufficient stand of grass. Minor erosion in the form of intermittent wave cut notches up to 1 ft high were present along the upstream slope at pool level. Some rutting due to vehicle traffic during wet ground conditions existed on the crest of the dam.

Both abutments included exposures of flat-lying, slightly to moderately weathered and broken, brown to gray shale overlain by sandstone. Rectangular joint patterns were noted, particularly in the sandstones. No faults were observed in the field during this investigation and geologic maps of the area do not show the presence of faults in the immediate vicinity.

The intake structure showed no signs of deterioration and all valves were reportedly in operational condition. The outlet pipe is a 48 inch diameter concrete pipe. The outlet pipe showed no signs of deterioration and the riprap plunge pool was intact.

The emergency spillway was grass lined and included riprap at the control section (centerline of dam). The downstream portion of the emergency spillway was badly eroded in the curvalinear section.

3.1.3 Reservoir Area: The reservoir area was free of debris and the perimeter was wooded. The reservoir is located in a valley with side slopes at approximately 2:1 to 3:1. No sediment buildup was detected near the intake structure.

3.1.4 Downstream Area: The downstream channel consists of a 4 ft wide by 2 ft deep channel located in a valley. The valley side slopes range from 2:1 to 4:1 and from open meadow to heavy woods. Approximately 200 ft downstream of the outlet structure, a roadway embankment crosses the stream. The embankment has a top elevation approximating that of the dam and a 72 inch culvert through it. Approximately one-half mile downstream there are two homes about 15 feet above the streambed, and one mile downstream there are two homes less than 10 ft above the streambed.

3.1.5 Instrumentation: No instrumentation (monuments, observation wells, piezometers, etc.) was encountered for the structure.

3.2 Evaluation:

3.2.1 Dam and Spillway: Overall, the dam was in satisfactory condition at the time of inspection. Based upon the age of the dam and amount of vegetation growing on the embankment at the time of the inspection, it would appear that a limited maintenance program exists for this structure. Uncontrolled growth promotes the development of deep rooted vegetation and this type of growth can encourage piping within the embankment. Also, excessive growth inhibits effective visual inspections of the dam. If a routine maintenance program does not exist, one should be initiated. The embankment, including its crest, slopes, and emergency spillway should be mowed at least once a year, but more preferably twice a year. Small trees presently growing on the embankment should be cut to the ground.

The wet spots, ponded water, and iron-stained seepage encountered along the lower portion of the downstream slope represent seepage through the dam. The seepage appears to be rather uniform across the downstream slope and no turbidity was noted during the inspection. This widespread seepage is of concern and it is recommended that the seepage along the downstream slope be monitored quarterly to detect any increase in flow rates which may cause piping within the embankment. If increased flows should occur, a professional Geotechnical Engineer should be contacted to evaluate the problem and make recommendations for required corrective measures.

The shallow gullies described on the right downstream slope do not create an unsafe condition. If more severe erosion should develop, corrective measures may be required to prevent further erosion. This erosion appears to be the result of surface runoff and not seepage through the dam. No corrective measures are required for the area described along the left downstream slope.

The intermittent wave cut bench present just above normal pool on the upstream slope does not create any hindrance to normal performance of the dam. Rutted areas on the crest of the dam should be corrected and reseeded in an attempt to decrease the susceptibility to surface erosion.

The intake and outlet structures are in good contition. The emergency spillway is in need of erosion control in the downstream channel. The erosion on the emergency spillway is not detrimental to the dam at this time, but left unchecked, could possibly be detrimental.

3.2.2 Downstream Area: The location of the roadway embankment immediately downstream of the dam will create a buffer if the dam is breached; however, this embankment may possibly fail after being impacted by the discharge from a possible dam breach. If water is impounded behind the roadway embankment to elevations approaching the dam crest, the potential for failure also exists, since it was not constructed as a dam. A high hydrostatic head on the roadway could create piping through the embankment, resulting in an embankment failure. The two homes one mile downstream would be jeopardized by a dam breach.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: Bear Creek Reservoir is used for recreational purposes and water supply. The normal pool elevation is maintained by a riser-type inlet acting as the principal spillway. During periods of normal flows, water flow is absorbed by the filtration plant and not maintained through the dam. Water supply is drawn off through a 10 inch supply line in the riser. During periods of above-normal flows, the pool elevation rises above the riser inlet increasing the flow through the inlet. Large increases in flows which cannot be absorbed by storage are passed through the emergency spillways when the pool rises above elevation 2533 msl.

4.2 Maintenance of Dam and Appurtenances: Maintenance is the responsibility of the Town of Wise, Virginia. Maintenance consists of inspection, debris removal, mowing of the vegetative cover, and repair. The operating appurtenances are reportedly in working order.

4.3 Warning System: No warning system exists.

4.4 Evaluation: The dam and appurtenances are in good operating condition. Maintenance of the dam is adequate. An emergency action plan should be developed and an emergency warning system should be implemented.

SECTION 5 - HYDRAULICS/HYDROLOGIC DATA

5.1 Design: No hydraulic/hydrologic data is available.

5.2 Hydrologic Records: There are no records available.

5.3 Flood Experience: An estimated maximum pool elevation of 2535± occurred in April 1977.

5.4 Flood Potential: In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. The Probable Maximum Flood (PMF) and ½ PMF hydrographs were developed by the SCS method (Reference 4, Appendix IV). Precipitation amounts for the flood hydrographs of the PMF and ½ PMF are taken from the U. S. Weather Bureau Information (Reference 5, Appendix IV). Appropriate adjustments for basin size and shape were accounted for. These hydrographs were routed through the reservoir to determine maximum pool elevations.

5.5 Reservoir Regulation: For routing purposes, the pool at the beginning of flood was assumed to be at elevation 2533 msl. Reservoir stage-storage data and stage-discharge data were determined from the available plan, field measurement and USGS quadrangle sheets. Floods were routed through the reservoir using the principal and emergency spillway discharge up to a pool storage elevation of 2540 msl and a combined spillway and non-overflow section discharge for pool elevations above 2540 msl. Floods were also routed through the

roadway culvert 200± ft downstream of dam using the dam spillway discharge data as the inflow hydrograph. Overtopping of the road embankment was assumed at elevation 2540 msl.

5.6 Overtopping Potential: The predicted rise of the reservoir pool and other pertinent data were determined by routing the flood hydrographs through the reservoir as previously described. The results for the flood conditions (PMF and ½ PMF) are shown in the following Table 5.1.

TABLE 5.1 RESERVOIR PERFORMANCE

		Hydrograph		
	Normal Flow	100 Year	½ PMF	PMF
Peak Flow, CFS				
Inflow	1	1707	6,909	13,818
Outflow	0	729	4,446	12,268
Maximum Pool Elevation (a) Ft, msl	-	2535.3	2,540.9	2,543.1
Non-Overflow Section (Elev. 2540 msl)				
Depth of Flow, Ft	-	-	0.9	3.1
Duration, Hours	-	-	1.0	3.0
Velocity, fps (b)	-	-	4.4	7.6
Emergency Spillway (Elev. 2533 msl)				
Depth of Flow, Ft	-	2.3	7.9	10.1
Duration, Hours	-	8	10	11
Velocity, fps (b)	-	7.6	12.4	13.5
Tailwater Elevation, (c) Ft, msl	2494	2520.8	2,542.1	2,543.6

(a) Assumes downstream roadway is breached.

(b) Critical velocity at control section

(c) If downstream roadway is not breached, these elevations would occur above and below the dam. Duration of flow over the spillway and non-overflow section would be slightly greater but with lower velocities.

5.7 Reservoir Emptying Potential: A 24-inch square gate at elevation 2500 msl is capable of draining the reservoir through the 48-inch diameter outlet pipe. Assuming that the lake is at normal pool elevation (2532 msl) and there is 1 cfs inflow, it would take approximately 3 days to lower the reservoir to elevation 2500 msl.

5.8 Evaluation: Department of the Army, COE, guidelines indicate the appropriate spillway design flood (SDF) for an intermediate size significant hazard dam is the ½ PMF to PMF. Because of the risk involved, the ½ PMF has been selected as the SDF. The spillway will pass 40 percent of the PMF (80% of the SDF). However, a downstream restriction will pass only 30 percent of the PMF creating a tailwater condition which will exceed the top of the dam. The SDF will overtop the dam a maximum of 0.92 ft, and remain above the dam for 1.0 hour with a critical velocity of 4.4 fps, assuming the road crossing is breached. If the road crossing is not breached, the dam will be submerged and the reservoir elevation will be the same as the water surface elevation above the roadway. This would increase the overtopping of the dam but decrease the velocity of overflow.

Hydrologic data used in the evaluation pertains to present day conditions with no consideration given to future development.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: Bear Creek Dam appears to be founded on alluvial and/or residual soils, all of which are underlain by the Norton Formation. Design drawings show the cutoff trench extending into bedrock or residual soils. Five test borings drilled at the site (Plate 8, Appendix I) penetrated 12 to 22 ft± of overburden before encountering bedrock. From 10 to 24 ft± of bedrock was drilled in each of the borings. The greatest overburden thicknesses occurred adjacent to the existing stream channel. The sampled overburden soils ranged from sandy to clayey materials and the underlying bedrock consisted of interbedded sandstones and shales with several thin seams of coal (from 0.2 to 2 ft thick). Water pressure test data presented on the boring logs suggests that at least the upper portion of the bedrock is somewhat weathered and/or fractured, thus allowing water loss during the testing. Local pressure grouting was performed in select areas during construction in order to minimize seepage potential. Slightly to highly weathered sandstones (Gladeville Sandstone) are exposed in the emergency spillway and right abutment. These sandstones are often iron-stained and include rectangular joint sets.

6.2 Embankment: Both the upstream and downstream slopes are 3 horizontal to 1 vertical with crest at elevation 2540 msl. As designed, the upstream slope is blanketed with a 2 ft± thick layer of 12 inch riprap from the toe of the slope to about elevation 2535 msl. Normal pool is elevation 2532 msl and the bottom of the emergency spillway is at elevation 2533 msl. Design drawings of the embankment are

presented on Plates 3 through 6 of Appendix I. According to Thompson and Litton, Inc., all fill was placed in 1 ft± thick layers and compacted with a sheepsfoot roller. Although field density tests were not required to determine the percent compaction, compaction procedures were observed by a full time inspector from Thompson and Litton's office. The "impervious" core was constructed with off-site soils, while on-site materials were used to construct the "pervious" shell. The underlying cutoff trench is approximately 20 ft wide and has side slopes of 1.5 horizontal to 1 vertical. A profile of the cutoff trench is provided on Plate 4 of Appendix I.

Side slopes of 1.5 horizontal to 1 vertical were excavated into the soils and bedrock in both abutments. Sandstone bedrock is exposed in the right abutment and emergency spillway, while residual soils and some sandstone are exposed behind the filter plant in the left abutment. The abutment slopes were considered safe and stable at the time of this inspection.

6.3 Evaluation:

6.3.1 Foundation and Abutments: Dam foundations must be evaluated on the basis of potential settlement, sliding, and seepage. Excessive settlement of the dam is not believed to be a problem because the structure appears to rest upon fairly competent bedrock and overburden soils. Since Standard Penetration Tests and detailed soil descriptions were not provided on the boring logs, the physical character of the soils can not be accurately determined. However, the performance history of the structure does indicate the adequacy of the underlying foundation materials. There is also no knowledge of subsurface

mines existing beneath the dam or the impoundment and therefore, settlement or subsidence caused by the collapse of subsurface mine workings is not anticipated. This could be a potential problem should subsurface mines ever extend beneath the reservoir.

Sliding within the foundation bedrock does not appear likely based upon the nature of the Norton Formation. A review of the geologic data indicates that even though some thin clay seams are present near the top of the formation, there are no adversely oriented weak planes within these seams or bedrock which would act as potential sliding planes.

Examination of bedrock exposed in the right abutment indicates that much of the underlying near-surface shale, sandstone, and coal would be jointed or fractured enough to allow seepage beneath the dam. This was also indicated by the pressure test data presented on the boring logs. In an attempt to control seepage beneath the dam, local pressure grouting was performed in the cutoff trench. Since complete design and construction data were not available, an accurate determination of the foundation conditions under the cutoff trench is not possible. It is not known whether seepage is passing beneath the cutoff trench.

6.3.2 Embankment: The iron-stained saturated areas located along the right downstream toe and the continuous saturated zone present along the basal third of the downstream slope are indicators of long-term seepage. The origin of the seepage could not be specifically

determined, but it is believed to be passing through the embankment soils. Design data supplied by the owner does not show the presence of a toe drain or drainage blanket. Past rainfalls have caused ponding along the downstream toe; however, there had been no rainfall for at least three days prior to the field inspection. Consequently, the saturated zone extending across the basal third of the downstream slope is believed to represent seepage through the embankment. It is recommended that the downstream toe be examined during dry weather to locate specific areas of seepage and estimate flow rates. Afterward, seepages should be monitored quarterly to detect any increase in flow rates which could result in piping through the embankment.

An accurate check on the stability of this structure cannot be made since stability analyses were not performed for design,and construction records are not available. Although a stability analysis was not performed for this dam, the structure was designed in accordance with recommendations presented in the First Edition of "The Design of Small Dams" by the U. S. Bureau of Reclamation. The downstream and upstream embankment slopes meet the requirements recommended by the U. S. Bureau of Reclamation for both the steady seepage and rapid drawdown conditions. Since no undue settlement, cracking, or flowing seepage were noted at the time of inspection, it appears that the embankment is adequate for maximum control storage with water at elevation 2532 msl. As previously stated, the saturated zone extending across the basal third of the downstream slope is of concern and should be monitored as recommended hereafter in Section 7.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: The Bear Creek Dam at the time of inspection appeared sound and in good condition. The appropriate SDF for this dam is the ½ PMF. The spillway will pass 40 percent of the PMF (80 percent of the SDF) without overtopping, and the dam will be overtopped by 0.9 ft during the SDF. Tailwater conditions permit less than 30% of the PMF to be passed. The emergency spillway is judged inadequate but not seriously inadequate.

The actual embankment structure appears to be generally similar to the design drawings. No stability analyses were performed; however, the dam was designed in accordance with recommendations presented in the First Edition of "The Design of Small Dams" by the U. S. Bureau of Reclamation. Available test boring data indicates that the dam is founded on soils and rock suitable for support of the dam.

The roadway embankment immediately downstream of the dam creates a tailwater elevation during the SDF which exceeds the top elevation of the dam and the roadway embankment by 2.1 ft for a period of 4.5 hrs. Overtopping of the roadway embankment by 2 ft could cause a failure of the embankment, resulting in the downstream flooding of several homes. A dramatic decrease in tailwater elevation also has the potential for creating severe erosion on the dam crest and downstream face which could ultimately result in dam failure.

The potential dam failure created by the downstream restriction results in an increased hazard to loss of life downstream. Because of this potential hazard, the dam is assessed "unsafe-non-emergency".

7.2 Recommended Remedial Measures: It is recommended that within two months of the date of notification of the Governor of the Commonwealth of Virginia, that the owner engage the services of a professional engineering consultant to complete the following action:

1) A detailed evaluation of the downstream flood plain should be completed as relates to hazard potential and Spillway Design Flood appropriate for this dam.
2) A detailed evaluation should be performed to determine the effects on the dam of the downstream restriction created by the roadway located about 200 ft below the dam. Consideration should be given to modification of the haul road to eliminate tailwater conditions at the dam which would exceed the dam crest and the road crest.

Within six months of the notification of the Governor, the consultant's report of appropriate remedial mitigating measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia for a reasonable time frame in which all remedial measures will be complete.

Until corrective measures are completed the dam should be checked during periods of heavy runoff. If dam overtopping is imminent, warning should be issued to the downstream inhabitants.

In the interim, an emergency operation and warning plan should be promptly developed. It is recommended that a formal emergency procedure be prepared, prominently displayed, and furnished to all operating personnel. This should include:

1) How to operate the dam during an emergency.

2) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

7.3 Required Maintenance and Observation:

7.3.1 Seepage present along the downstream slope is of concern since it appears to indicate widespread seepage through the dam. The downstream slope should be monitored quarterly and after high pool levels in the reservoir to detect any increase in flow rates which may cause piping within the embankment. If increased flow rates should occur, a professional Geotechnical Engineer should be contacted to evaluate the problem and make recommendations for required corrective measures.

7.3.2 The grass and weeds on the embankment and the emergency spillway should be cut at least once and preferably twice a year. We would recommend maintenance in the early summer and fall.

7.3.3 All small trees or sapplings present on the embankment should be cut to ground level yearly during maintenance operations.

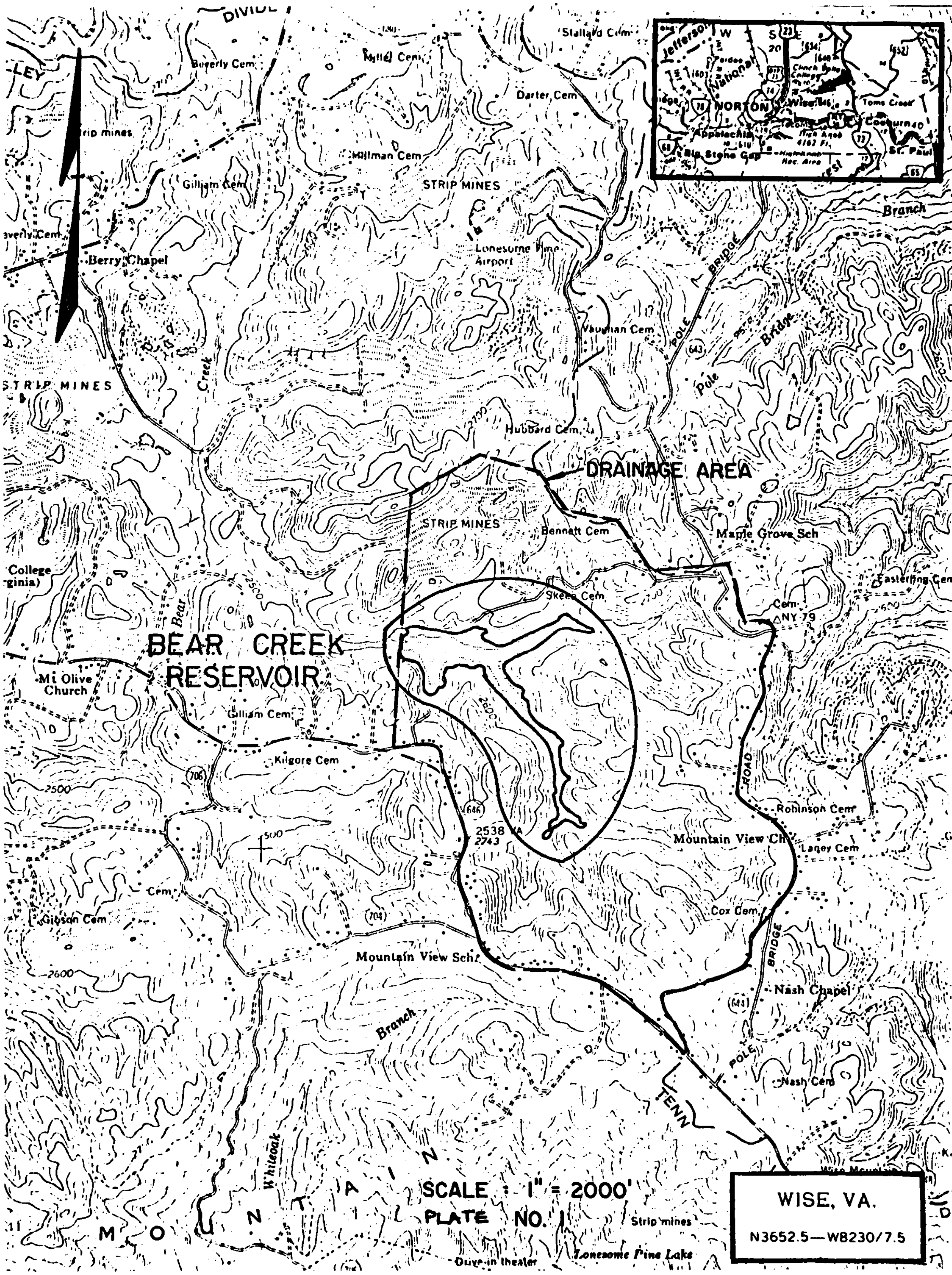
7.3.4 The eroded area in the emergency spillway should be corrected during the maintenance operations.

7.3.5 Rutted areas on the dam crest should be corrected and reseeded during the maintenance operations.

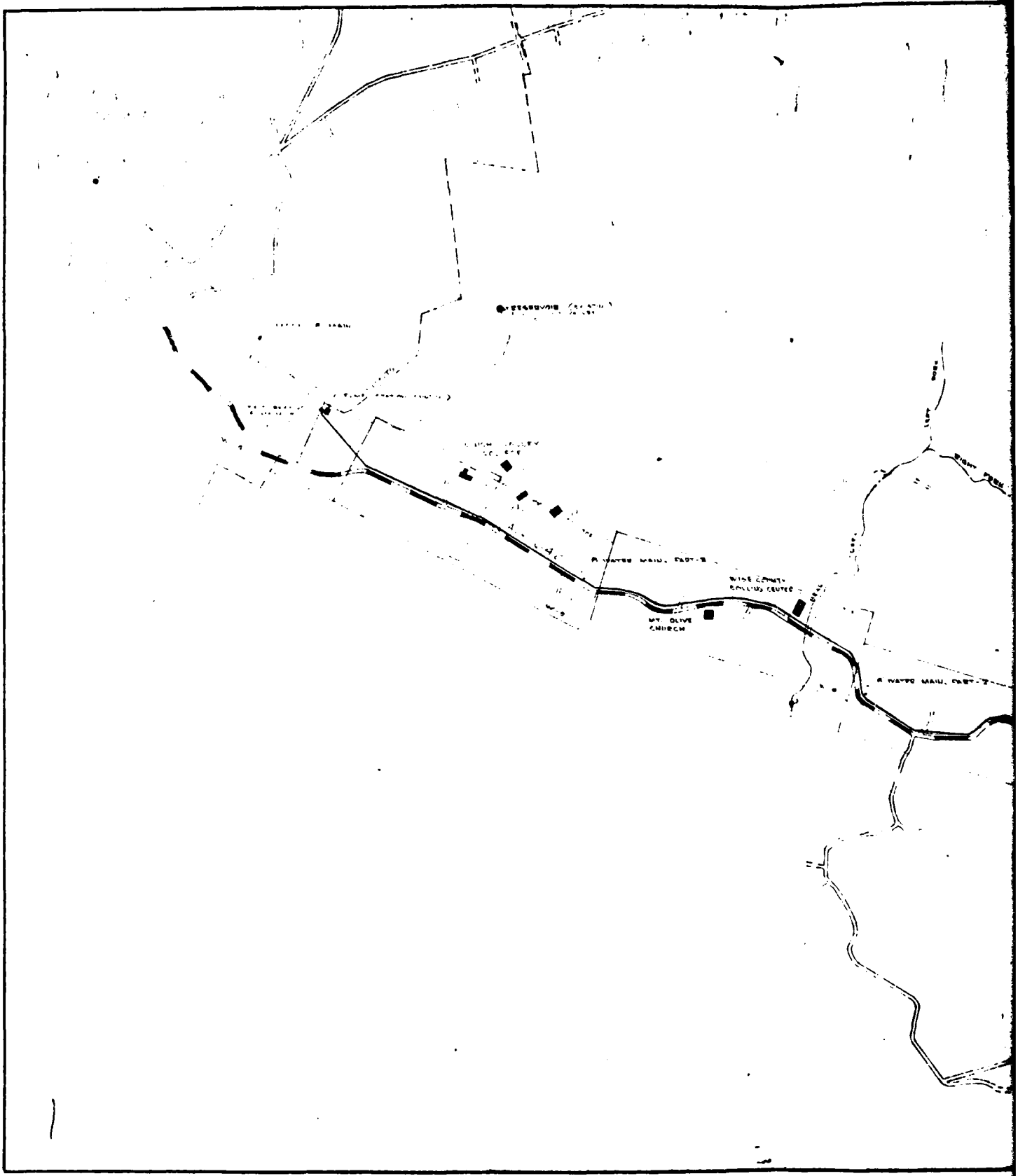
7.3.6 A staff gage should be installed to monitor water levels.

APPENDIX I

MAPS AND DRAWINGS



BEAR CREEK RESERVOIR
DRAINAGE AREA
STRIP MINES
Strip mines
Berry Chapel
Gilliam Cem
Hillman Cem
Darter Cem
Stallard Cem
Lonesome Pine Airport
Vaughan Cem
Hubbard Cem
Bennett Cem
Maple Grove Sch
Skeen Cem
Easterling Cem
Mt Olive Church
Kilgore Cem
Robinson Cem
Mountain View Ch
Laney Cem
Cox Cem
Gibson Cem
Mountain View Sch
Nash Chapel
Nash Cem
Bear Creek
Pole Bridge Branch
POLE BRIDGE ROAD
Whiteoak Branch
M O U N T A I N
TENN
Drive-in theater
Lonesome Pine Lake
NORTON
Wise
Appalachia
Big Stone Gap
Coeburn
St. Paul
Toms Creek
SCALE : 1" = 2000'
PLATE NO. 1
WISE, VA.
N3652.5—W8230/7.5


MT. OLIVE
CHURCH

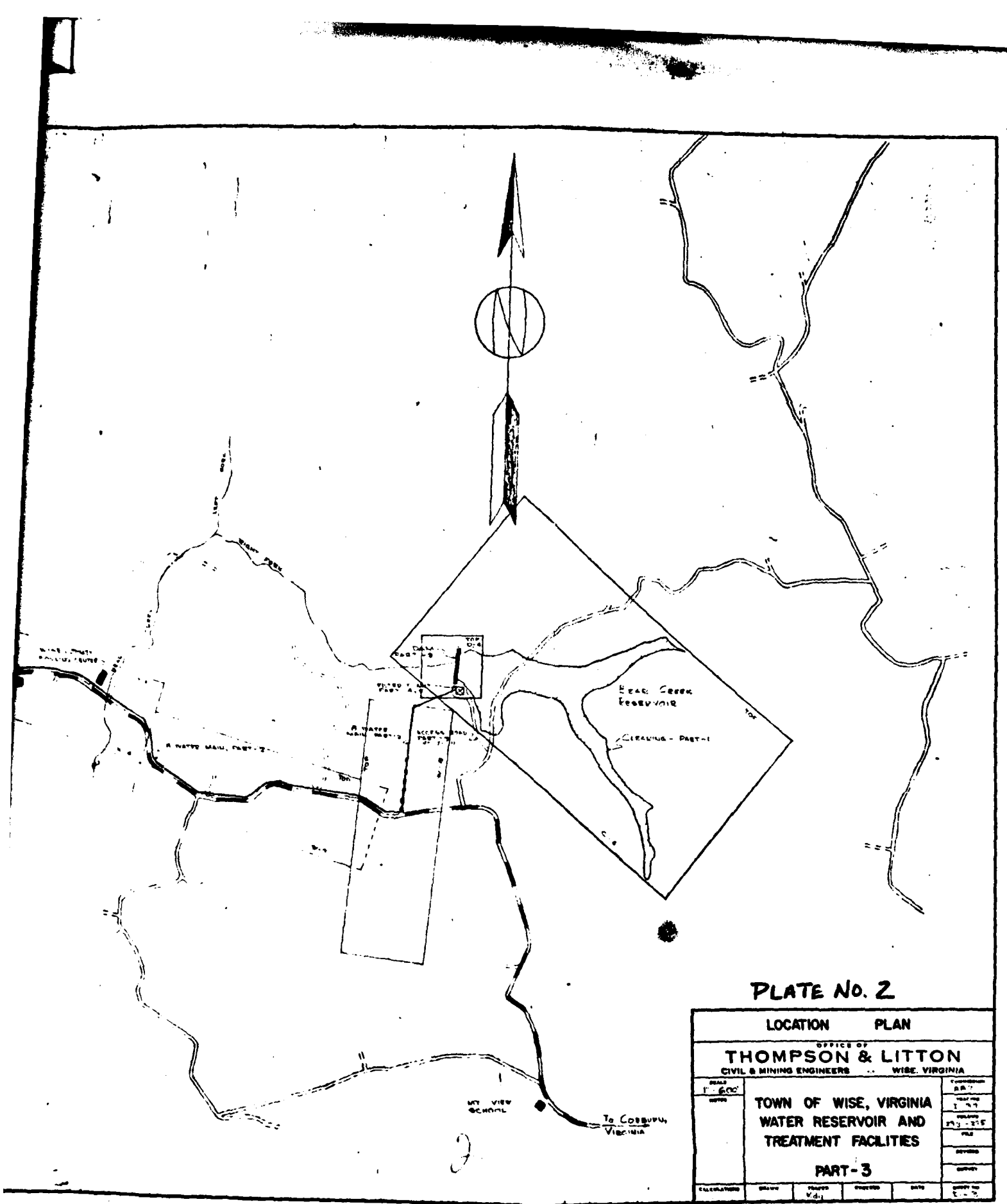


PLATE NO. 2

LOCATION PLAN

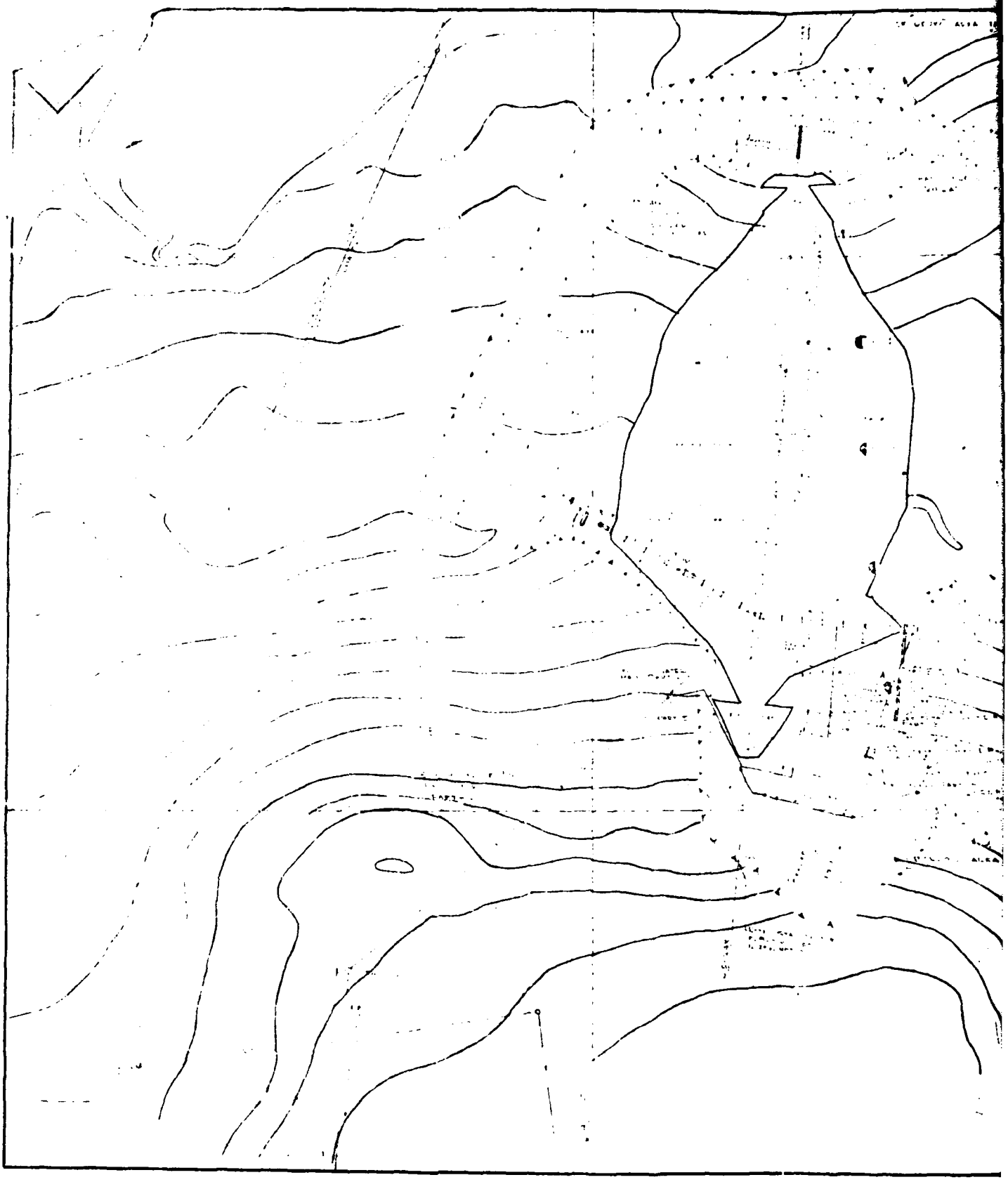
OFFICE OF
THOMPSON & LITTON
CIVIL & MINING ENGINEERS -- WISE, VIRGINIA

SCALE 1" = 600'

TOWN OF WISE, VIRGINIA
WATER RESERVOIR AND
TREATMENT FACILITIES

PART-3

CALCULATED | DRAWN | TRACED Vdu | CHECKED | DATE



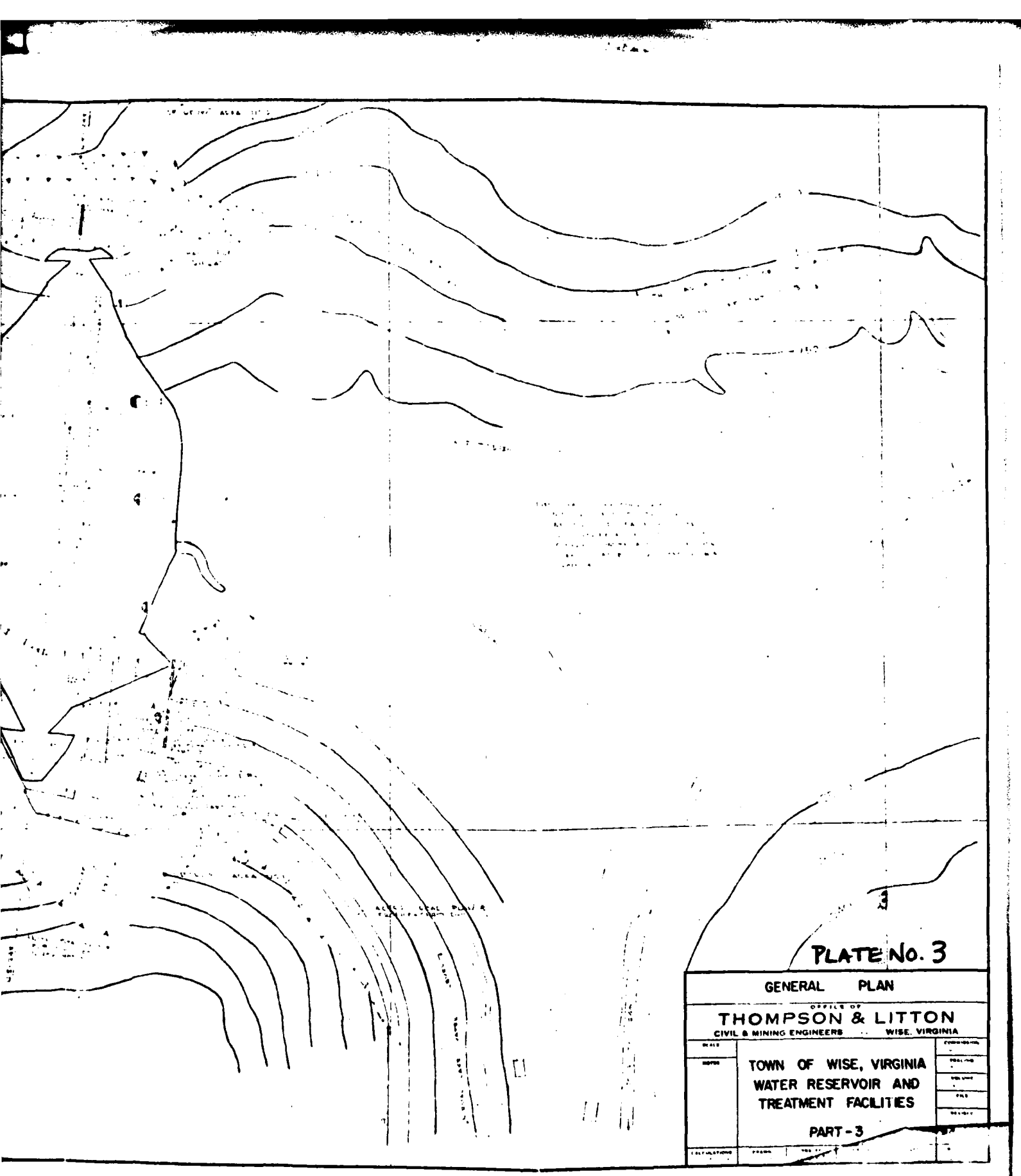


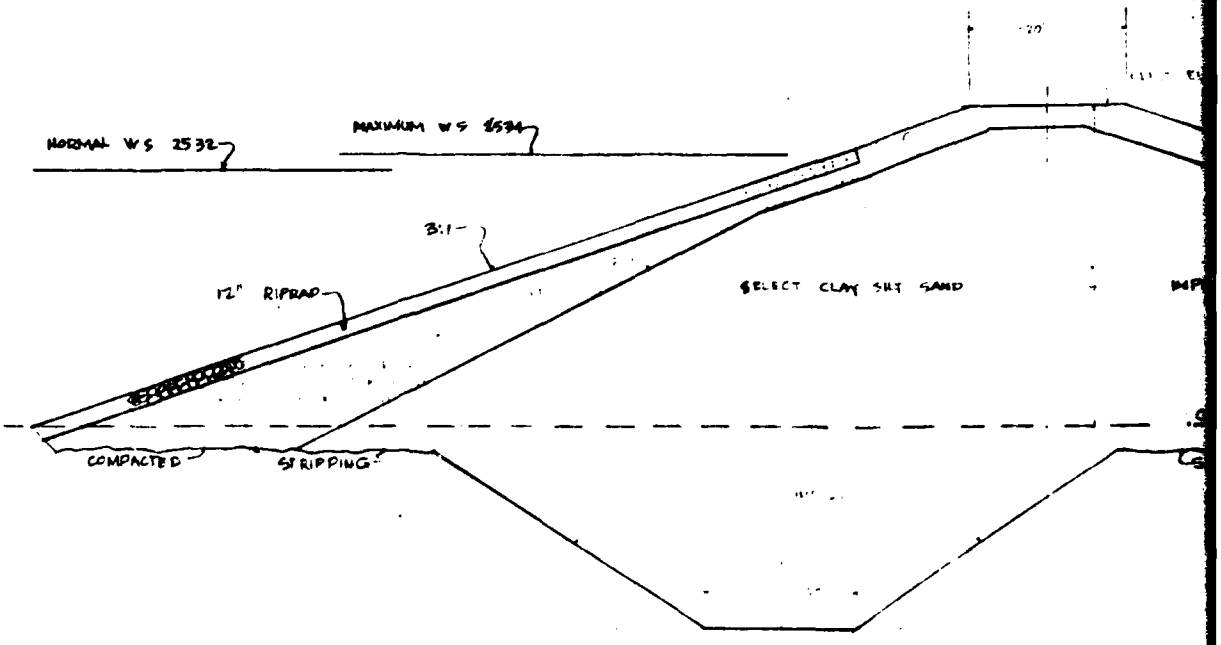
PLATE NO. 3

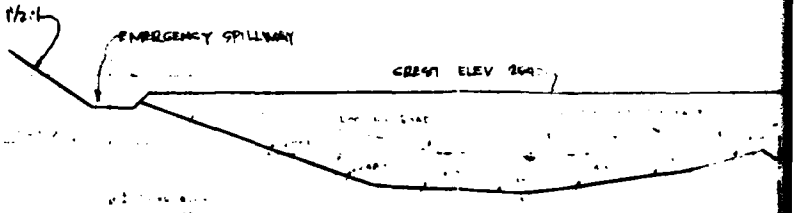
GENERAL PLAN

OFFICE OF
THOMPSON & LITTON
CIVIL & MINING ENGINEERS WISE, VIRGINIA

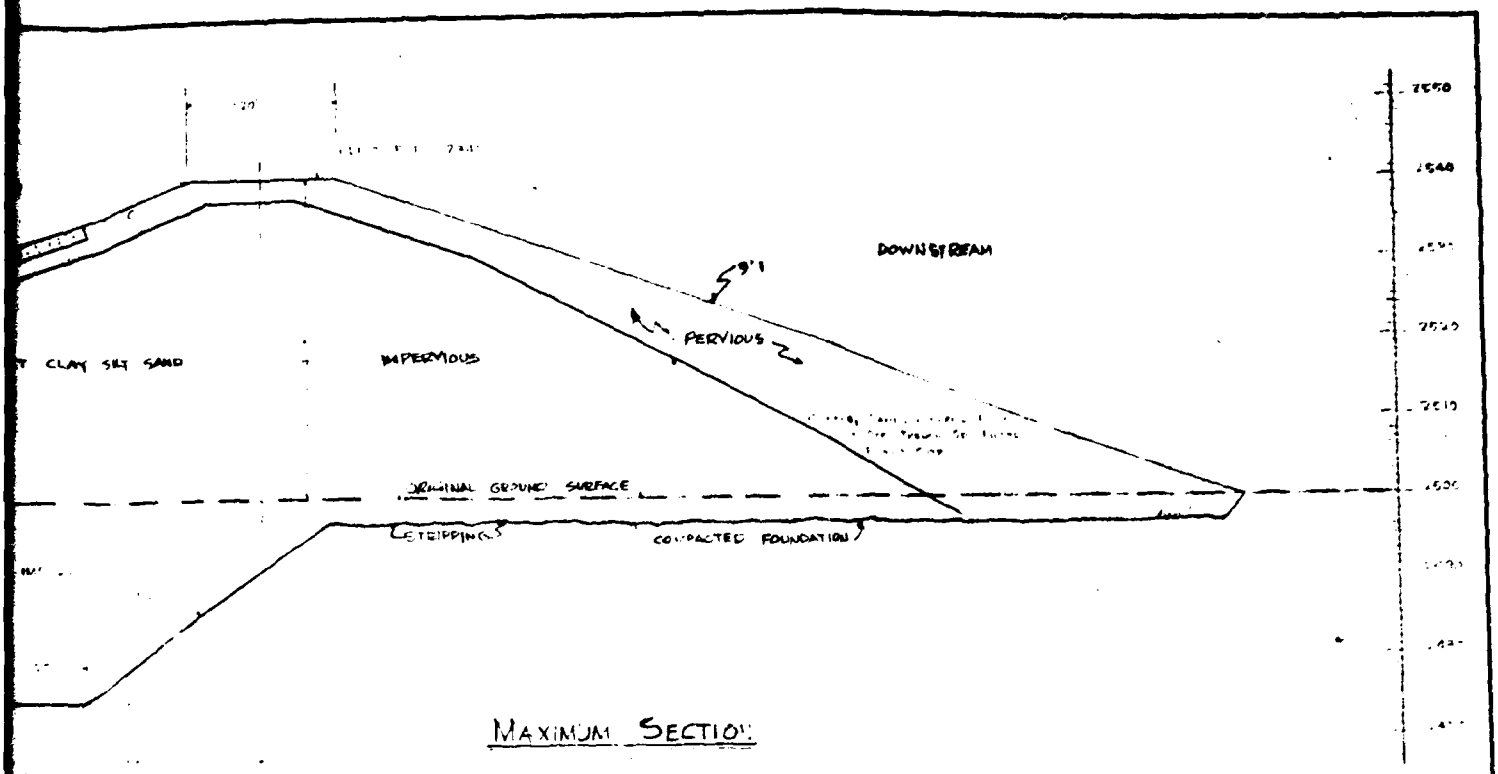
TOWN OF WISE, VIRGINIA
WATER RESERVOIR AND
TREATMENT FACILITIES

PART - 3





PROFILE ON ℄ CREST OF DAM



MAXIMUM SECTION

ON & CREST OF DAM

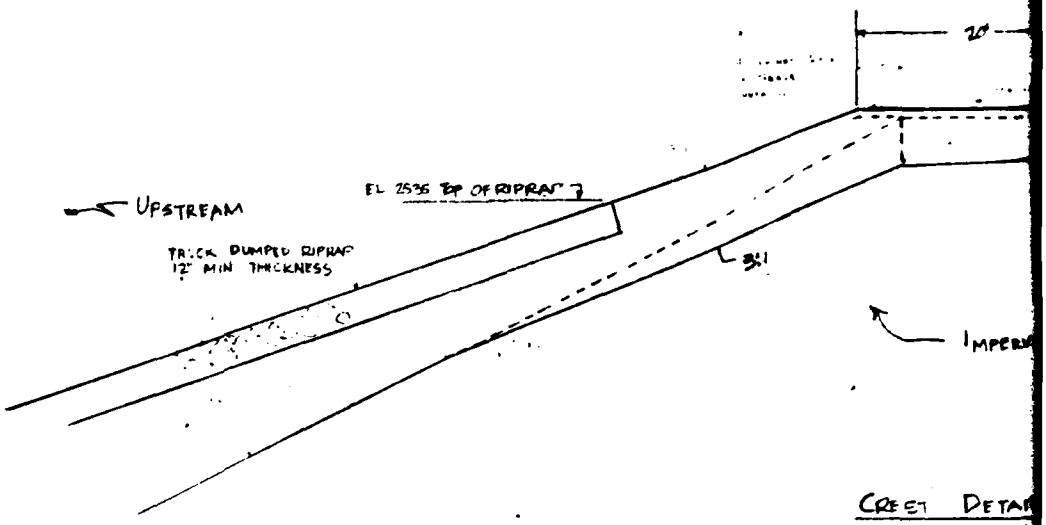
PLATE No. 4

CONSTRUCTION DETAILS

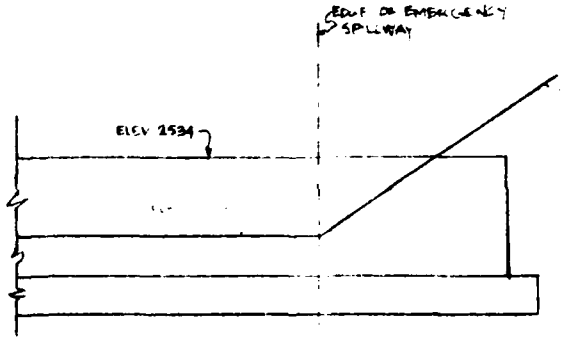
OFFICE OF
THOMPSON & LITTON
CIVIL & MINING ENGINEERS WISE, VIRGINIA

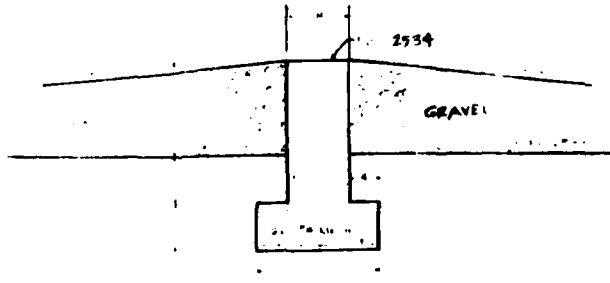
TOWN OF WISE, VIRGINIA
WATER RESERVOIR AND
TREATMENT FACILITIES

PART-3

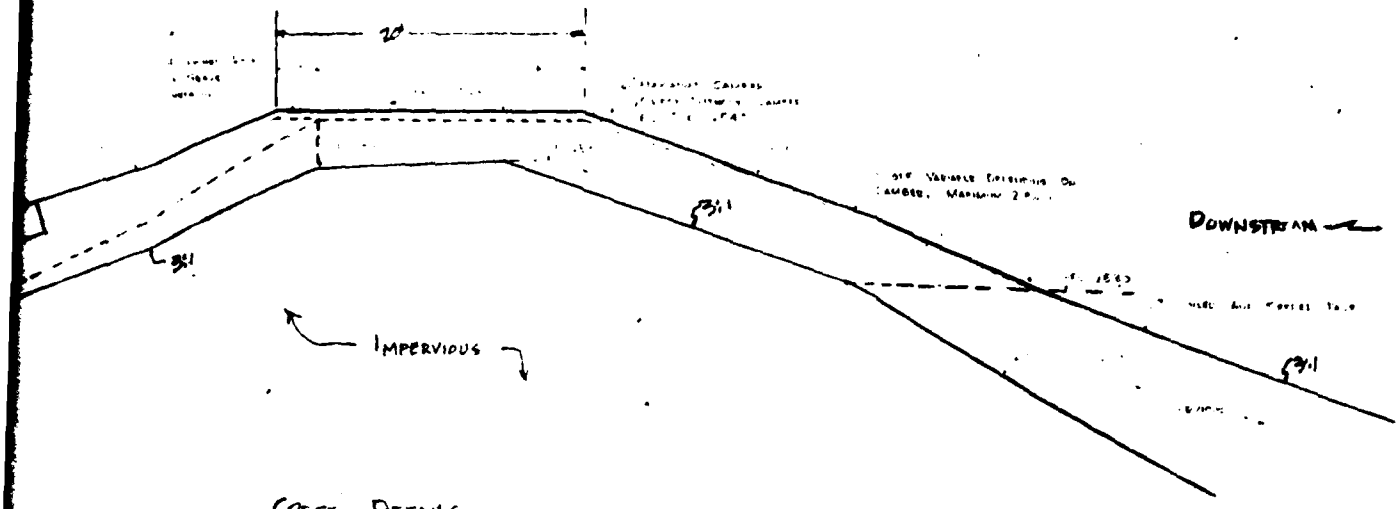


CREST DETAI

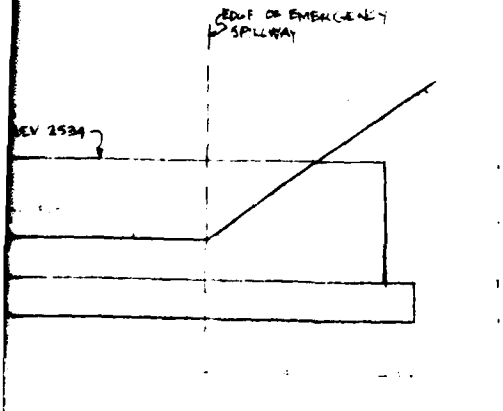




SPILLWAY



CREST DETAILS



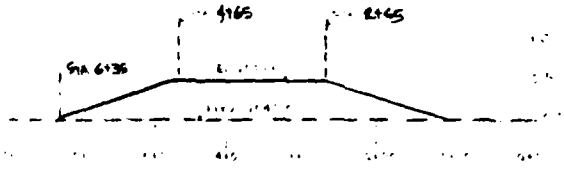
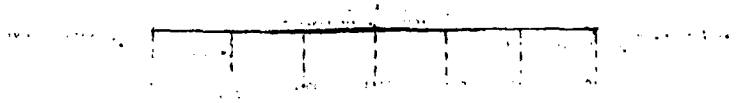


DIAGRAM SHOWING CAMBER ON CREST OF DAM



PROFILE ALONG ℄ SPILLWAY

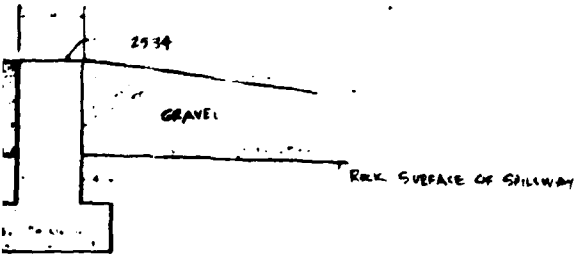


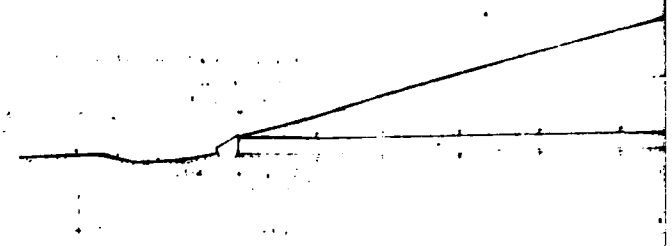
PLATE NO. 5

CONSTRUCTION DETAILS

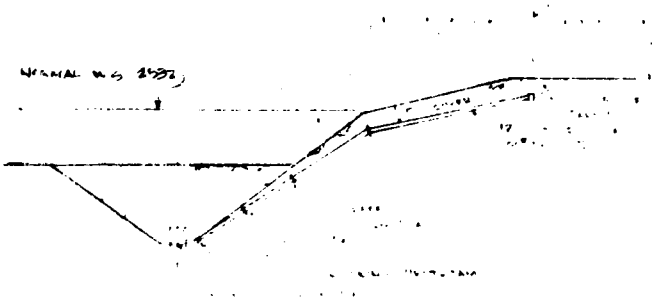
OFFICE OF
THOMPSON & LITTON
CIVIL & MINING ENGINEERS WISE, VIRGINIA

TOWN OF WISE, VIRGINIA
WATER RESERVOIR AND
TREATMENT FACILITIES

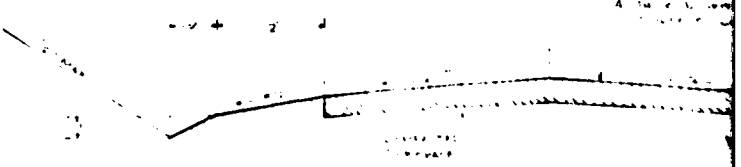
PART - 3

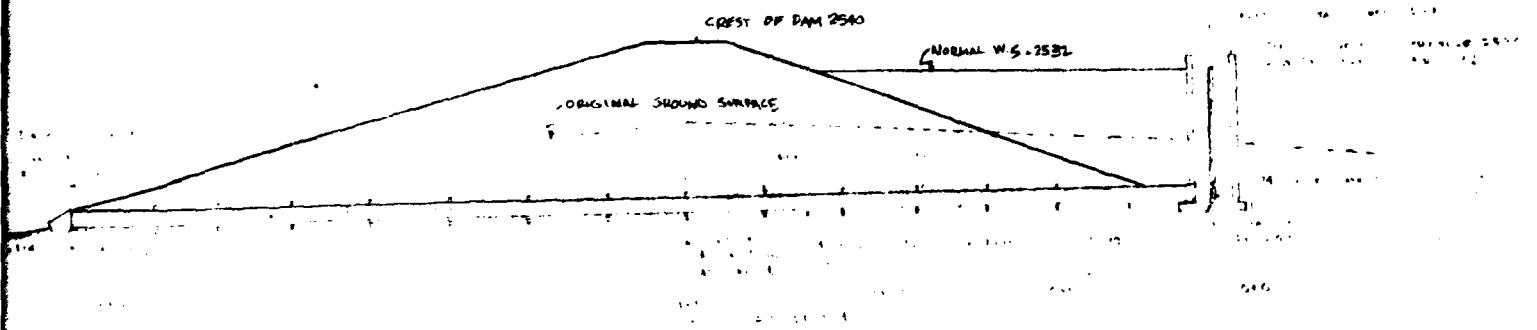


PROFI

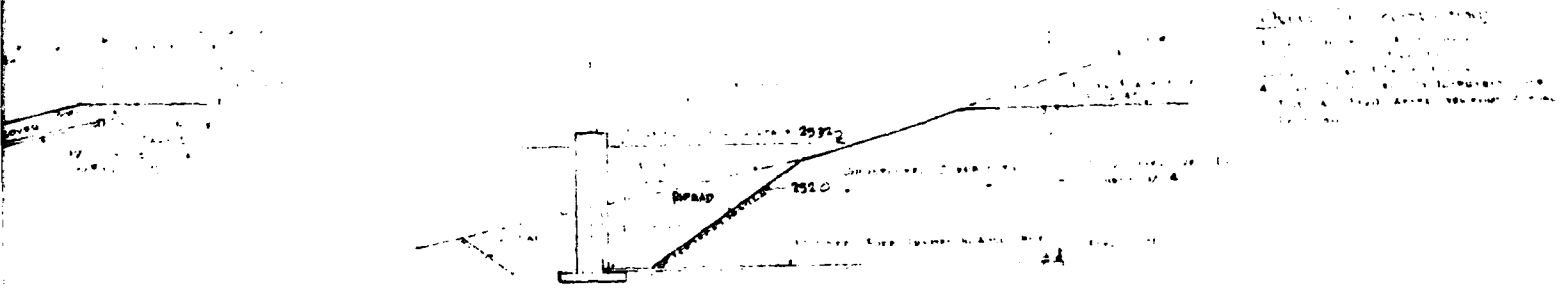


PROFILE ALONG ℄ OF PIPE SEWER
FOR FILTER BA





PROFILE ALONG ℄ OF OUTLET WORKS



PROFILE ALONG WATER SUPPLY

PIPE SEWER

BACK

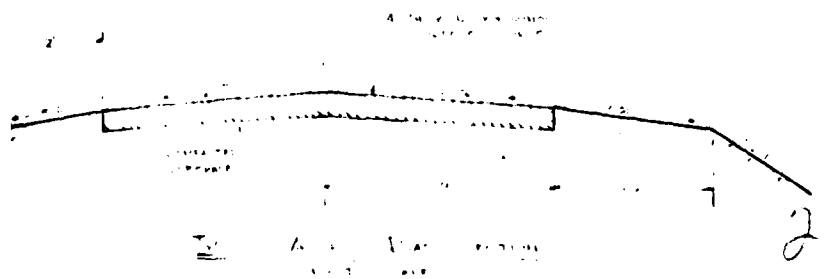
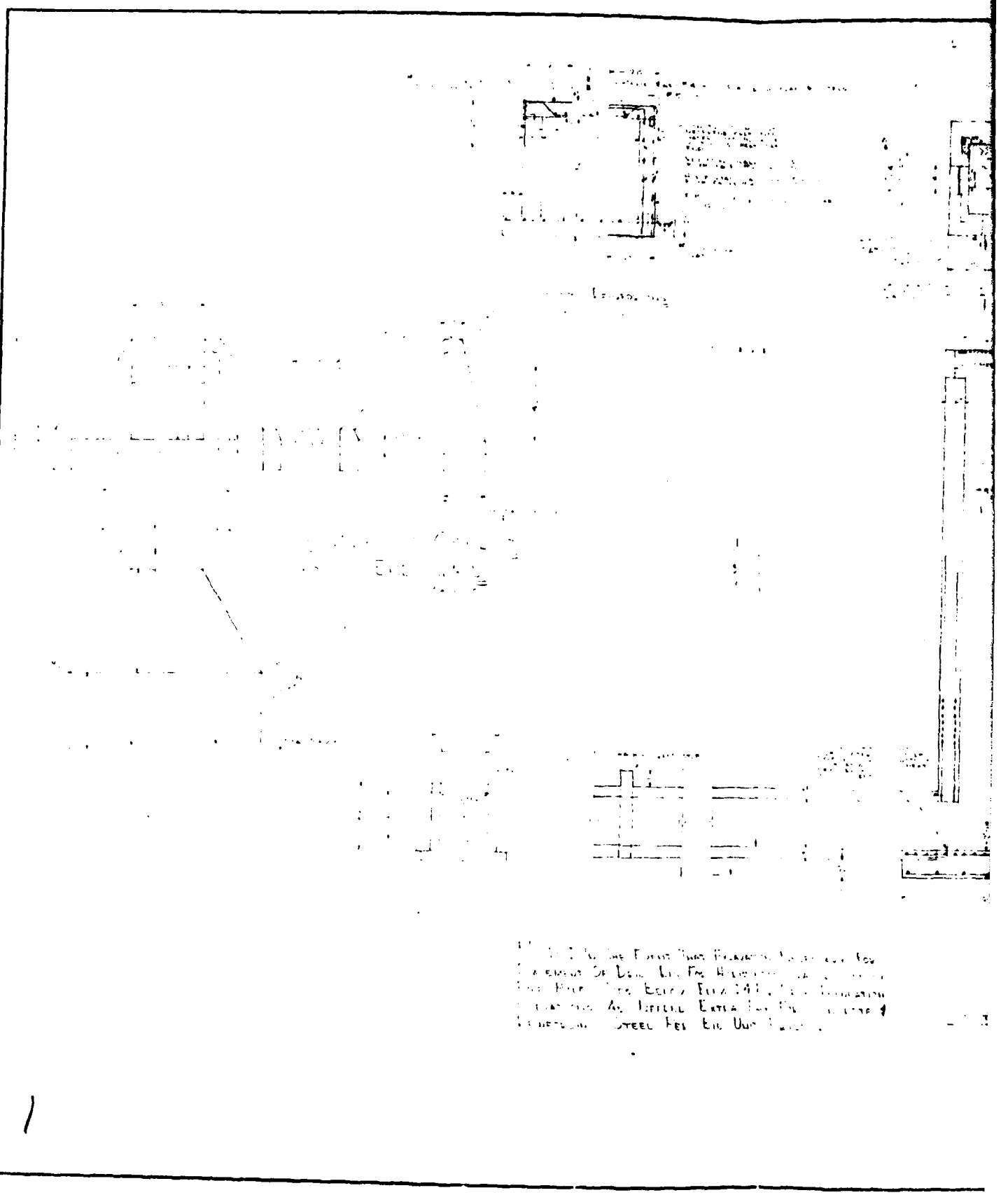


PLATE NO. 6

CONSTRUCTION DETAILS

OFFICE OF
THOMPSON & LITTON
CIVIL & MINING ENGINEERS WISE, VIRGINIA

TOWN OF WISE, VIRGINIA
WATER RESERVOIR AND
TREATMENT FACILITIES
PART-3



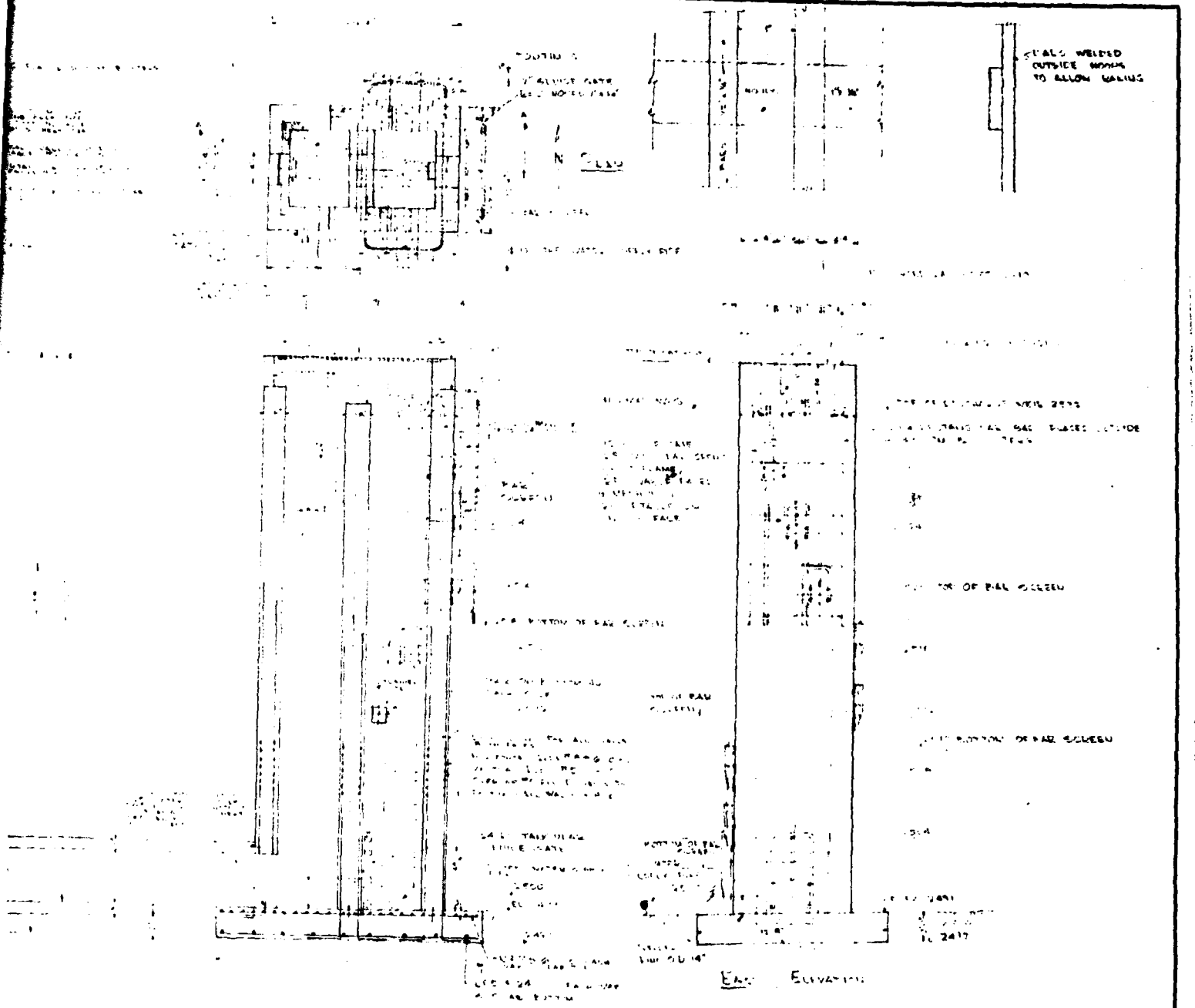


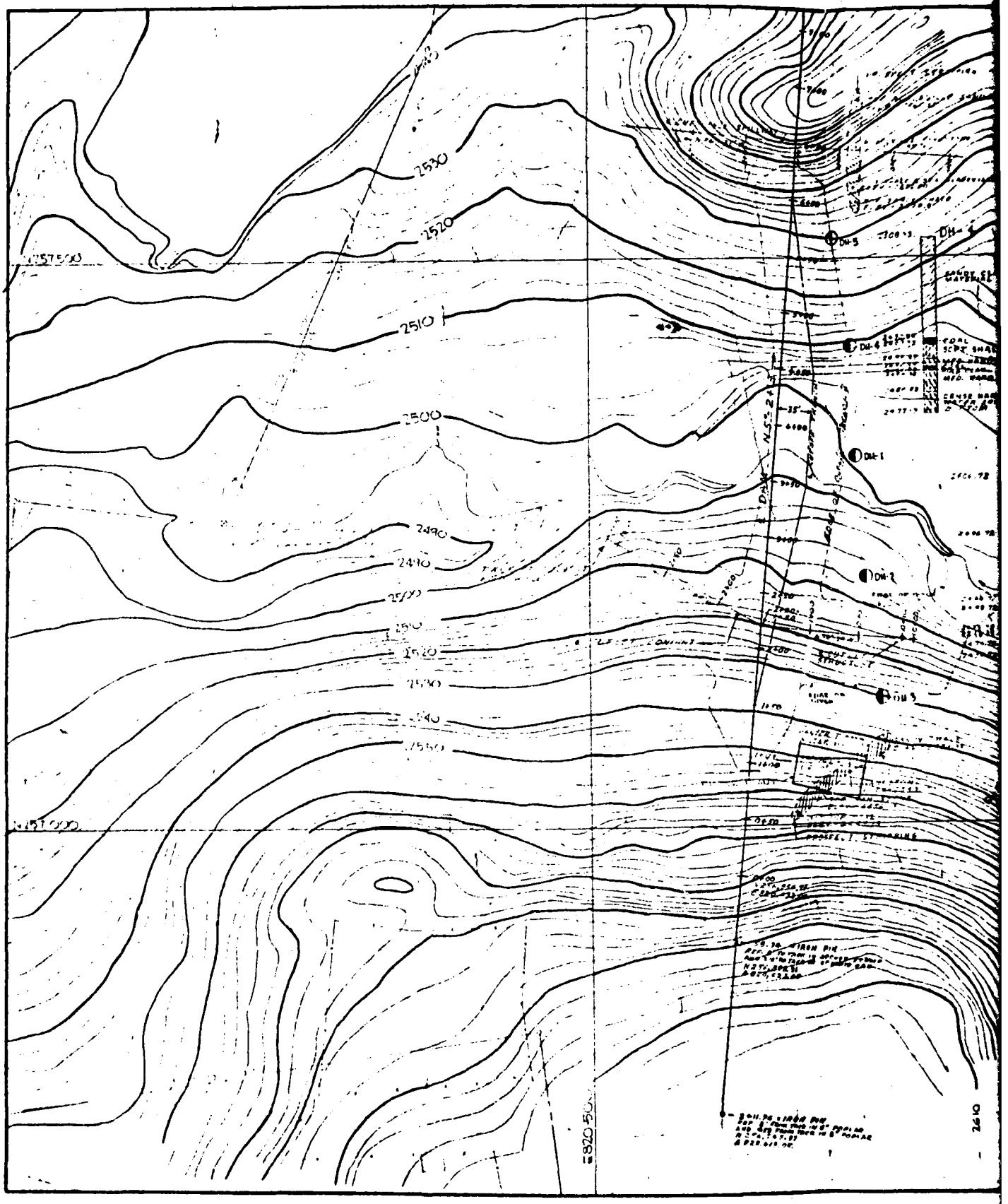
PLATE NO. 7

OUTLET STRUCTURE DETAILS

OFFICES OF
THOMPSON & LITTON
CIVIL & MINING ENGINEERS — WISE, VIRGINIA

TOWN OF WISE, VIRGINIA
WATER RESERVOIR AND
TREATMENT FACILITIES
PART - 3

OUTLET STRUCTURE


2530
2520
2510
2500
2490
2480
DH-5
DH-4
DH-1
DH-2
DH-3

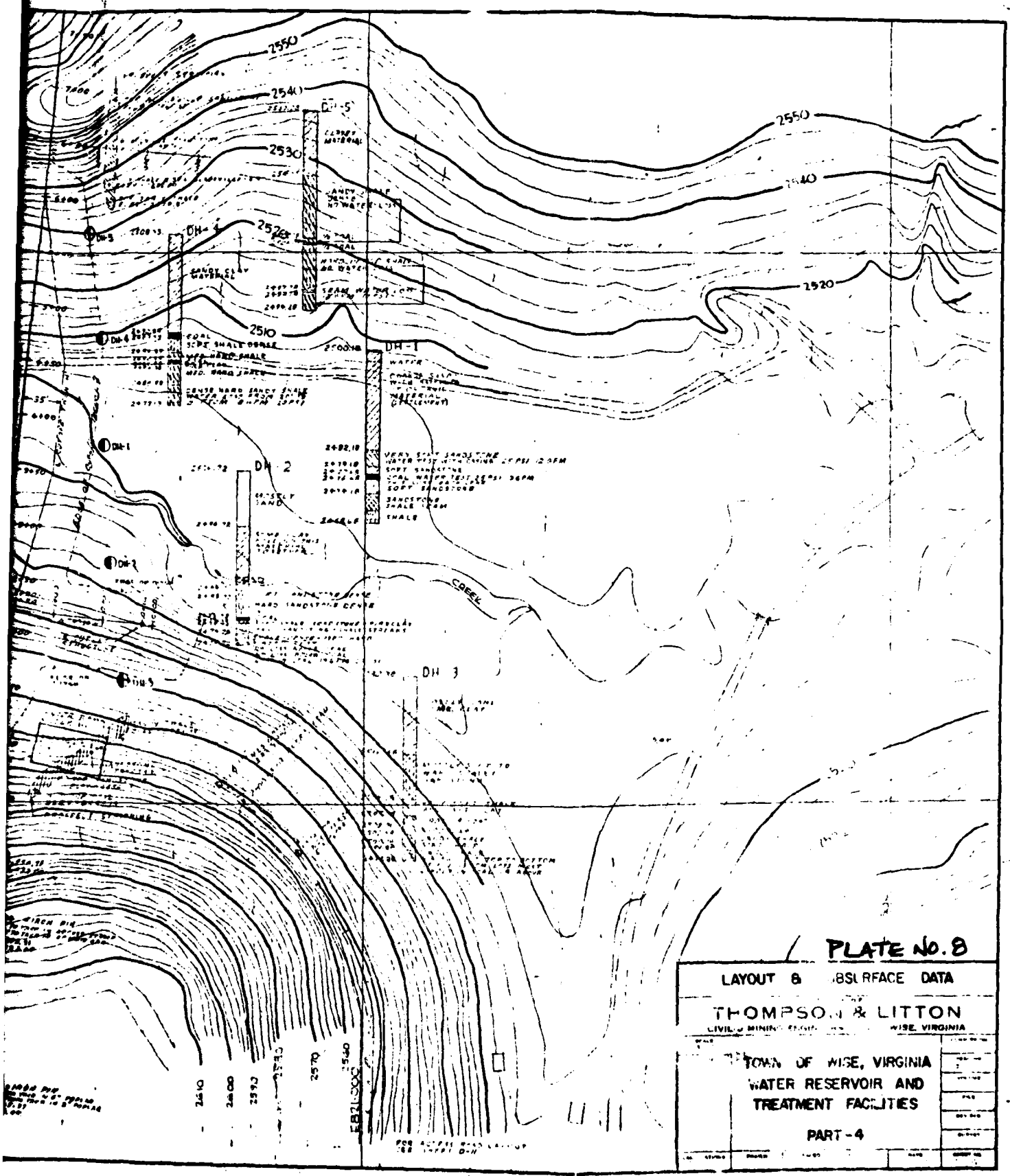


PLATE NO. 8

LAYOUT & SUBSURFACE DATA

THOMPSON & LITTON

CIVIL & MINING ENGINEERS WISE, VIRGINIA

TOWN OF WISE, VIRGINIA
WATER RESERVOIR AND
TREATMENT FACILITIES

PART - 4

APPENDIX II

PHOTOGRAPHS

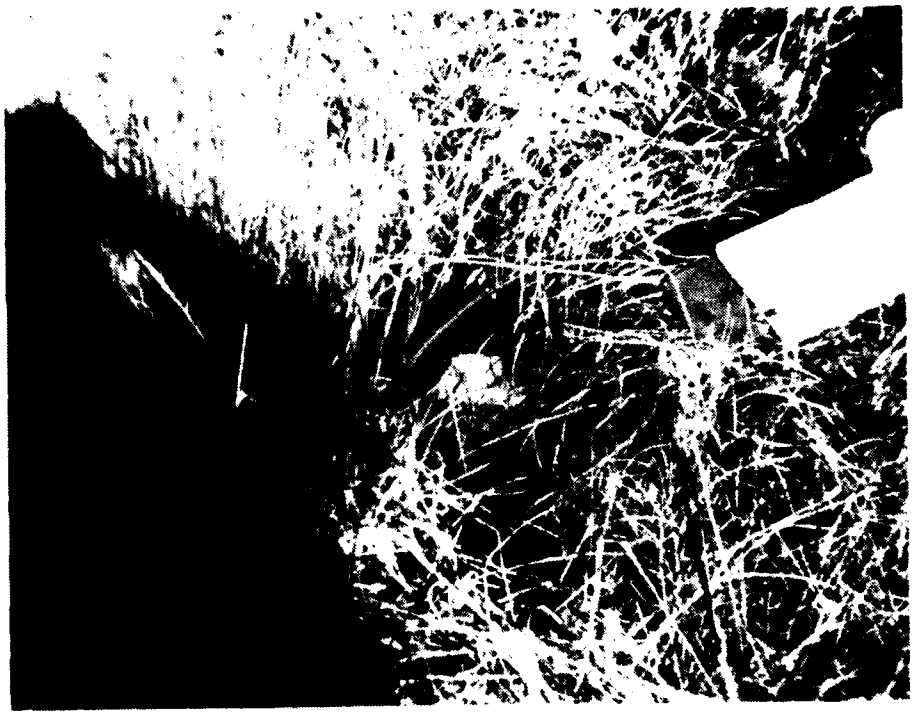
Photograph No. 1
Reservoir

Photograph No. 3
Looking at Spillway at Toe of Dam

Photograph No. 4
Looking at Spillway at Centerline of Dam

Photograph No. 5
Downstream Channel, Note Hard Road Immediately Downstream

Photograph No. 6
Plunge Pool



Photograph No.
Downstream flood plain at [illegible].
Stream bed is at left side about
6 feet below the yard area.

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam Bear Creek County Wise State Virginia Coordinators Lat 36°-58.1' Long 82°-32.0'

Date(s) Inspection 12/11/79 Weather Clear Temperature 55° F

Pool Elevation at Time of Inspection 2532 msl Tailwater at Time of Inspection 2494 msl

Inspection Personnel:

Schnabel Engineering Associates, P.C.
Ray E. Martin, P.E.
Stephen G. Werner (recorder)

J. K. Timmons and Associates, Inc.
Robert G. Roop, P.E.
Donald Balzer (recorder)

State Water Control Board
Ed Constantine
Leon Musselwhite

Thompson & Litton, Inc.
Edwin M. Phillips

Town of Wise, Virginia
Larry Couch, Town Manager

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	The slopes, crest, emergency spillway, and abutment contact were inspected and no cracks were noted. The downstream and upstream embankments and portions of the spillway were covered with 2 to 3 ft high grass. Several small (1 to 3" diameter) trees were also growing at scattered locations along the center and right side of downstream slope and at a single location on the upstream slope.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movements or cracking were noted on the dam or downstream beyond the embankment toe.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing was noted. The left embankment dam contact was eroded previously but is presently corrected with good growth of ground cover. Erosion in this area appeared to be the result of water expelled from a storm drain system which exits through a 6 inch± pipe 1/4 of the way down the embankment-abutment slope. Several minor erosion gullies less than 1 ft deep were encountered midway down the downstream slope-right abutment interface. Minor erosion in the form of intermittent wave cut notches up to 1 ft high were present along the upstream slope at pool level. Some rutting due to vehicle traffic was also present on the crest of the dam.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	The vertical and horizontal alignment of the dam appeared to be good.	
RIPRAP FAILURES	Spot riprap was observed above pool level on the upstream slope. Riprap ranging from several inches to 3 ft± in length was visible below water level. No failures were observed.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The right abutment ties into gray to brown partially weathered and fractured sandstone. Gray to brown shale is exposed in the lower portion of the spillway channel. The left abutment appears to tie into residual soil; however, similar sandstone and shale bedrock is exposed in the upper and lower portions of the cut, respectively, behind the water treatment plant. Bedrock is essentially flat-lying and rectangular joint patterns were noted, particularly in the sandstones. The west end of the emergency spillway appears to contain a number of large sandstone boulders which are up to 4 ft± in length. No faults were observed during the inspection.	
ANY NOTICEABLE SEEPAGE	Scattered wet spots, standing water and iron-stained seepage were observed in a general line as shown on the accompanying field sketch. Essentially the entire basal 1/3 to 1/4 of the downstream slope is saturated and very spongy. This condition appears to be the result of long term seepage through the dam. Accumulated flow from the right side of the downstream slope was estimated at 5 gpm as the combined flow passed in front of the principal spillway pipe. Seepage observed during the site visit was clear and essentially free of turbidity.	
STAFF GAGE AND RECORDER	None observed	
DRAINS	None Observed	

EMERGENCY SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	None	Not applicable
APPROACH CHANNEL	Width = 30 ft Grass lined, no erosion, riprap bottom at control section	Good condition
DISCHARGE CHANNEL	Some side slope erosion. (Badly eroded in the curvalinear portion)	Generally in good condition
BRIDGE AND PIERS	None	Not applicable

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed	Good condition
INTAKE STRUCTURE	No indication of effervesence No leaks observed Trash rack clean Values reported to be operational	Good condition
OUTLET STRUCTURE	48" concrete pipe with end walls	Good condition
OUTLET CHANNEL	Stable plunge pool No erosion noted Riprap in place	Good condition
EMERGENCY GATE	Reportedly operable Hand crank kept in secured area	Good condition

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gentle to mederately steep, vegetated to wooded slopes bound the reservoir except along the right side where scattered bare cut slopes (2:1 to 3:1±) occur. No sloughing or failure of these slopes was observed.	
SEDIMENTATION	None observed, water was clear. Sounding at intake structure indicated no appreciable depth change from plan requirements.	

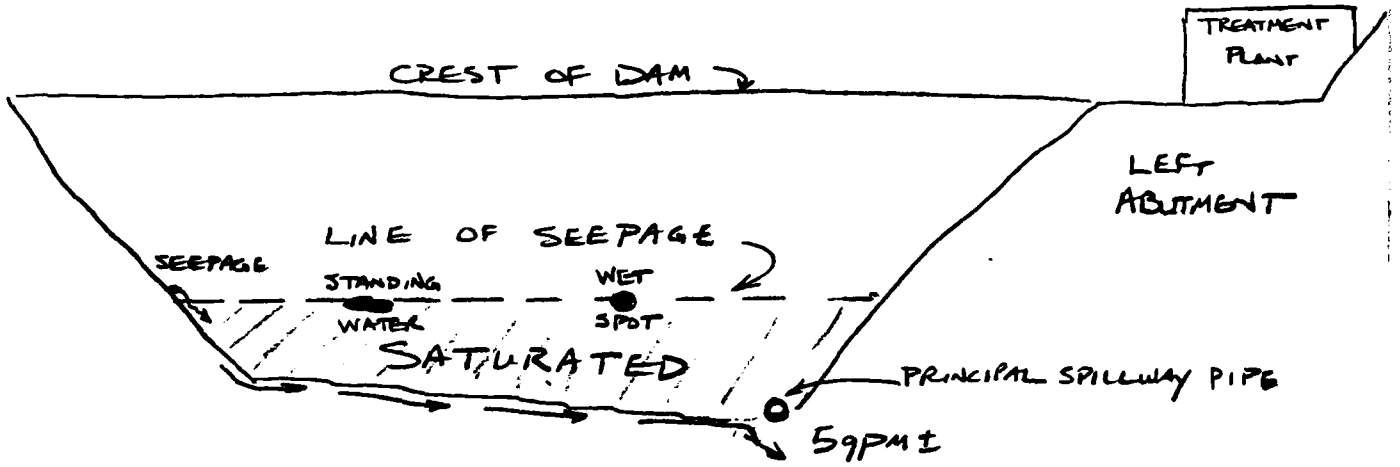
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Box culvert (bridge) on Rt. 646. 72" CMP culvert (no head wall) ½ mile downstream 72" CMP culvert (no head wall) @ Mining Haul Road Mining Haul Road constructed across downstream channel approximately 200 ft below outlet structure. Top of road elev. = top of dam. Downstream channel is 4 ft wide by 2 ft deep.	
SLOPES	2:1 side slope (200'± flood plan), no crosion noted. Area is wooded and open.	
APPROXIMATE NO. OF HOMES AND POPULATION	Two homes on Rt. 646 10'± above stream centerline. (Approximately one mile downstream). Two homes 15'± above stream center line approximately ½ mile downstream.	
REMARKS	Mining Haul Road would impede water downstream but could fail if dam failure was to occur.	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	Not Applicable
OBSERVATION WELLS	None observed	Not Applicable
WEIRS	None	Not Applicable
PIEZOMETERS	None	Not Applicable
OTHER		

BY REM DATE 12/11/79 SUBJECT FIELD SKETCH SHEET NO 9 OF 9
CHKD. BY SW DATE 1/30/80 BEAR CREEK RESERVOIR DAM JOB NO V79485



NO SCALE

LOOKING UPSTREAM

SEEPAGE – 2/3 WAY DOWN ON RIGHT ABUTMENT – DAM CONTACT

STANDING WATER – 2/3 WAY DOWN – IRON STAINED SEEPAGE

WET SPOT – 2/3 WAY DOWN – SMALL ZONE OF SEEPAGE WITH SWAMP GRASS. NO FLOW BUT SPONGY.

APPENDIX IV - REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Department of Army, Office of the Chief of Engineers, 46 pp.
2. Design of Small Dams, U. S. Department of Interior, Bureau of Reclamation, 1974, 816 pp.
3. The Geology and Mineral Resources of Wise County and the Coal-Bearing Portion of Scott County, Virginia, Bulletin 24, J. Brian Eby, Virginia Division of Mineral Resources, 1923, 617 pp.
4. Section 4, Hydrology, Part 1 Watershed Planning, SCS National Engineering Handbook, Soil Conservation Service, U. S. Department of Agriculture, 1964.
5. Hydrometerological Report No. 33, U. S. Department of Commerce, Weather Bureau, U. S. Department of Army, Corps of Engineers, Washington, D.C., April 1956.